Objective Review of Monopolar Radio Frequency Device: ContinuousWater Cooling and Single Radio Frequency Pulse III

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Director Sang Hyuk Park of Shinchon ES Clinic, Vice President of the Korean Academy of Obesity & Aesthetic Treatment, is enthusiastic about a variety of non-invasive cosmetic treatments. His current focus is on a monopolar radio frequency (RF) with continuous water cooling method and single RF pulse. With this method the temperature can easily be increased while greatly reducing side effects. This is achieved through the accumulating thermal diffusion effect as there is no heat loss caused by pulse division. We are presenting Director Sang Hyuk Park's RF treatment story over three articles.

There are two additional issues to consider when using circulating chilled water. The first is reverse thermal diffusion resulting from extended contact cooling, and the second is a surface cooling delay due to a short pulse interval. Due to these two phenomena, the cooling temperature of the epidermis becomes significantly higher than the set chilled water temperature during the actual procedure.

To assess the degree of epidermal protection, the author measures the epidermal temperature immediately after the single radio frequency (RF) pulse using an infrared thermometer, keeping the safe temperature range (38–42°C) in mind, with a finger on the opposite side. At this time, the skin surface and the temperature change of the contact cooling surface are measured and assessed (Figure 1).

The temperature of the dermis can exceed 60°C. The contact duration is 1,000 ms for a single shot using VOLNEWMER, during which the contact surface temperature rises in reverse due to reverse thermal diffusion on the skin with an elevated temperature. In the case of an instantaneous cooling method using sprayed refrigerant, the epidermal cooling is uniformly maintained by the sprayed refrigerant. It does not affect the procedure even if the surface temperature rises due to reverse thermal diffusion. However, in the case of slow cooling using circulating chilled water, the temperature of the contact surface, which has increased >30°C due to reverse thermal diffusion immediately after energy irradiation, gradually decreases as the chilled water circulates.

Fig. 1.1 Skin temperatur e measuremen t accordin g to each single RF pulse procedur e using an infrare d thermome ter

More than a few seconds are required for the temperature to drop to ≤20℃. If the procedure is performed while maintaining long shot intervals, regardless of the total treatment time, the next shot can be performed with a predictable cooling effect after the contact surface temperature is sufficiently lowered. However, it can be inferred that cooling of the contact temperature will be performed at a significantly higher temperature than the set chilled water temperature while moving the tip with shot intervals of 0.4 or 0.6 seconds. It should be noted that the set chilled water temperature and contact surface temperature range at high levels depending on the treatment shot interval. The shorter the shot interval, the higher the contact sur face temperature can be. On the one hand, unnecessary dermal cooling due to prolonged cooling time may be judged to be almost insignificant. On the other hand, the contact surface temperature may be significantly higher than the device setting. It is crucial to consider the above points and not overestimate the cooling effect. Nevertheless, the author's experience is that the procedure could be performed (over 100 cases) without side effects such as burns even when the maximum output level of 5.0 (115W) in 0.4 s repeat mode was used, and the patient’s pain was controlled entirely with sedation. Even today, the procedure generally begins at level 4.5 and ends at levels 4.0 or 3.5, with a pulse interval of 0.4 s. While it will be necessary to derive the optimal balance between the pulse interval and energy level from more cases, it can be inferred that the chilled water temperature set to 12-20℃ maintains the epidermal temperature at ≥30℃ in practice. There is no increased risk of side effects when performing the procedure with a high energy level, even with this level of contact surface temperature, if contact cooling is performed for a duration of 1,000 ms. Ultimately, VOLNEWMER should provide safe combinations of pulse interval and energy level parameters by studying multiple treatment cases in the short term and demonstrating the cooling temperature of the contact surface according to procedure speed through experimental measurements in the long run. A Key Factor for an Effective Procedure: Pain In monopolar RF treatment, the epidermis is maintained at 38–42℃ through cooling, but the heat-induced pain on the dermis cannot be avoided due to heat transfer at ≥60℃. The cooling system has great significance in pain control because excellent epidermal cooling decreases pain and enables higher energy level procedures. The gate control theory or pain is applied to most devices, and they are equipped with a horizontal or vertical vibration function. This function produces the analgesic effect of non-pain stimulation, such as vibration, which closes the pain transmission gateways and blocks the pain sensation from being transmitted to the brain. To use much higher-power energy, the epidermal cooling capacity must handle the high-power energy, but patients must also be able to withstand the heat pain. In other words, even if the skin is protected by excellent cooling, the devices' high-power energy cannot be utilized if the patient cannot tolerate pain. The epidermal cooling capacity is determined the moment a device is introduced. Anesthetic cream application, minimal sedation through nitrous oxide inhalation, or moderate sedation procedures using sedatives, such as propofol, can be additional pain control. Pain control allows for maximum utilization of the output of a device. Without sufficient pain control, it will be impossible to determine the superiority of devices currently on the market.

Discussion

Differences and Meaning of the Maximum Output When comparing RE devices, there is a tendency to evaluate their performance based on the highest output claimed by each manufacturer. Based on the details of the Ministry of Food and Drug Safety approval of 4 cm2 cartridges, the maximum output of device A is 173W, 115W for device B, 140W for device C, and 115W for VOLNEWMER. The better the epidermal cooling capacity and the more effective the pain control, the higher the device's energy can be used. For a device's maximum output to be meaningful, a sufficient condition should be satisfied in which the epidermal cooling capacity of a device prevents burns even at high power and the patient can withstand pain. When pre-procedure treatment for pain on the treatment site is a simple application of anesthetic cream or not provided at all, the procedure must be performed using relatively low energy, requiring more shots to yield a significant result. Accordingly, devices with outstanding epidermal cooling capacity reduce pain and need fewer high-energy shots, allowing more efficient procedures. When pain is fully controlled through sedation, it is also possible to perform procedures utilizing the highest permitted energy for the device's cooling capacity. Subjective Clinical Evaluation Device A's output is lower than the peak power at the most frequently used energy levels of 2.5–3.0 compared to its peak power of 173W at level 8.0. Device B has an output of 115W at level 9.5, but its output is 65-75W at the most used levels of 4.5-5.5. The risk of burns is present at level 7.0 with an output of 90W or higher, even when pain is controlled completely. Device C has an output of 140W at level 6.0, and the most commonly used energy levels of 2.0-2.5 have an output of 55-64W. However, when the level is increased to 3.0, DCD cooling that is prolonged to 20-30 ms becomes activated and enables procedures using levels 3.0-4.0 with an output of 74-96W without burns. VOLNEWMER has an output of 115W at level 5.0, and the following should be considered. First, its continuous cooling function of 1,000 ms using chilled water of 12-20°C is excellent. Even the most frequently used high-power levels of 2.5–3.0 (65–75W) can be used without risk of burns. Second, continuous cooling enables single RF pulse procedures. As there is no heat loss from pulse division, the thermal diffusion effect can be accumulated, and the temperature can be easily raised. In other words, the efficiency of the single RF pulse procedure is better than the same output method that raises the temperature using 5-6 pulses of 200 ms.

Multicooling & Multi RF Pulse .vs. Continuous Cooling + Single RF Pulse

The value of multi-cooling and multi-pulse is significant in laser procedures that can cause damage to chromophores distinct from surrounding tissues, such as epidermal melanin or dermal blood vessels. However, in the conventional monopolar RF that uses DCD and contact cooling methods for epidermal cooling, the DCD temperature of -26°C poses the risk of frostbite and pigmentation when cooling is longer than 100 ms, and the epidermis cannot be sufficiently cooled due to insufficient diffusion time when cooling is shorter than 10 ms (so DCD is used for a duration of 10-100 ms). Because procedures using long pulse duration cannot be performed due to the above limitations, it has been intended to increase the dermal temperature gradually using the 20 ms multi-cooling of DCD and the 200 ms multi-RF pulse method. While this method has historical significance as the origin of monopolar RF devices, contemplation on whether it is the best energy transfer method is necessary. In this respect, VOLNEWMER's continuous cooling and single RF pulse methods are innovative.

General Review

The particularities brought about by VOLNEWMER's new ideas are as follows. First, it has an excellent continuous cooling function of 1,000 ms using chilled water at 12-20°C. Even the most frequently used energy levels of 2.5–3.0 (65–75W) can be performed without pre-procedure treatment. From personal clinical experience, if pain can be controlled more, burns are not of concern even at a higher output of 3.5–4.5 (85–105W).

Second, continuous cooling enables single RF pulse procedures without heat loss from pulse division. This accumulates the thermal diffusion effect and enables a smooth temperature increase. The efficiency of the single RF pulse procedure is considered better even when compared to the same output method that raises the temperature with 5–6 pulses of 200 ms. Third, unnecessary cooling at shallow dermal areas is minimized using chilled water, whose thermal diffusivity is 1/100, as a medium at a relatively high temperature of 12-20°C. Nevertheless, there are also limitations to new ideas. In slow cooling with chilled water circulation, the contact surface temperature drops gradually due to reverse thermal diffusion immediately after energy irradiation. That is, the procedure is performed without the temperature of the procedure site decreasing to the set chilled water temperature due to the surface cooling delay phenomenon. If the shot intervals are maintained for a long time regardless of the procedure duration, the next shot can be performed after the contact surface temperature is sufficiently lowered. However, when the shot intervals are short, as in actual clinical practice, it can be inferred that the contact surface is cooled significantly higher than the set chilled water temperature. It should be noted that the procedure can be performed at various levels depending on the physician's shot interval.